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ABSTRACT

Using a specific teaching model as the criterion, three groups of elementary school teachers with differing levels of teaching experience were observed with a microcomputer recorder while teaching in their classroom settings. A step-wise discriminant analysis isolated specific motivational and instructional techniques from the model which produced a distirctive pattern of separation between the three groups. A classification analysis correctly identified 63 percent of all the observation cases by their teacher group. An analysis of recurring patterns of teaching, based on this model, also clearly indicated unique motivational and instructional techniques between the three levels of teaching experience. (Author)

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A DISCRIMINANT ANALYSIS OF A TEACHING MODEL USING THREE LEVELS OF TEACHING EXPERIENCE

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A DISCRIMINANT ANALYSIS OF A TEACHING MODEL USING THREE LEVELS OF TEACHING EXPERIENCE

INTRODUCTION

What specifically do teacher educators instruct teachers to do? What are the teacher competencies that will insure learning? From what sources are these competencies derived? Much of what has been taught in teacher education institutions comes from a base of professional intuition and past experience rather than a research base (Rosenshine, 1971). Though there has been little consensus as to a specialized set of concepts and vocabulary about teaching (Hudgins, et al, 1974), recent reports of comprehensive teacher effectiveness studies are beginning to identify possible variables that define teacher-pupil relationships which do contribute to gains in cognitive achievement (Rosenshine and Furst, 1971; Dunkin and Biddle, 1974; Bloom, 1976; Borich and Fenton, 1977).

The purpose of this study was to look carefully at the overt classroom teaching behaviors of three groups of teachers at varying levels of experience and training to see what, if any, specific differences occurred in their teaching behaviors. Which teacher competencies would discriminate between the three groups of teachers?

Furthermore, to expand this study, rather than selecting a potpourri of observable teacher-pupil behaviors from the vast list of classroom observational tools available, the author chose to use a

teaching model or "generic framework" (Borich and Madden, 1977), from which to select the specific teacher-pupil observational variables.

Methods

Teaching Model

Nuthall and Snook (1973) indicate that three dominant teaching models have traditionally provided the stimulus and structure for much of the recent teaching research, i.e., the behavior-control model, the discovery-learning model, and the rational model. These models have served as "interpretive frameworks" (Polanyi, 1953) upon which data have been organized and research activities directed.

The generic framework or teaching model for this study was derived from two sources. First, a unique systems analysis approach called "Fault Tree* Analysis" (Haasl, 1965; Ericson, 1970; and Stephens, 1972) was used to generate a basic outline of the teaching process. Secondly, this outline or framework was further modified based on the current literature on teaching and the sources of professional intuition and experience previously mentioned.

The basic underlying principle of the Fault Tree Analysis is as follows: the probability of success in any system can be increased by analyzing the most likely modes of failure that could occur within that system. Analysis in terms of success is much more problematic than analysis in terms of failure. It is difficult to achieve consensus as to those functions which lead to a system's success (or what teaching behaviors lead to learning), yet, experience has shown

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*"Fault Tree" was so named because of the completed graphic portrayal of a functional system which is analogous to the branching outline of a coniferous tree.

that it is much easier to describe and achieve consensus as to what constitutes failure (Witkin, 1973).

The teaching model used in this study was initially derived as a result of applying the Fault Tree Analysis to the question: "Why do teachers fail?". From the data generated by classroom teachers, administrators, and teacher trainers, in answering this question, and prioritizing the causes for teacher failure, a generic teaching model (tree) was generated. (See Figure 1.) At the apex of this model is the basic overall process of teaching. This process branches into the two main sub-processes of motivating and instructing. Put in the failure language, teachers fail because they fail in motivating (creating a desire to approach a task), and instructing (systematically presenting the learning content). Level with these two processes is the failure to know the content. The process of motivation fails because of the breakdown of the two major sub-processes of the teacher being an example and of the lack of student self-control. The process of instruction fails because of lack of designing and presenting techniques and the skillfull use of resources. Each of these third level functions were divided into more specific failure points. Figure 1 takes the reader to the fourth level of the tree. The complete Fault Tree analysis for this study was quite extensive going into numerous branchings.

Category System

Based on this generic teaching model, a categorical observation system was developed which first, represented low-inference behaviors,

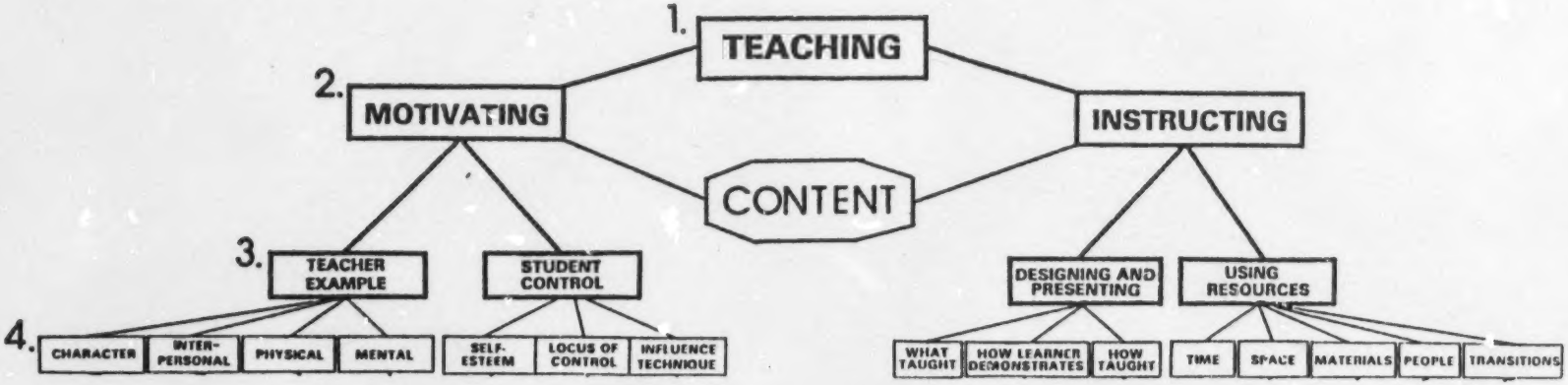

Figure 1

A Generic Teaching Model
At Four Basic Levels

i.e., behaviors which were observable and reliable as to the agreement of their occurrence. Secondly, all behaviors represented could be recorded as they occurred in the classroom. And, thirdly, multiple, simultaneous coding and modifying of the behaviors was provided by the system (Rosenshine, 1971).

The specific observational categories or competencies used in this study reflected the basic classroom motivational and instructional strategies employed by teachers as outlined in the Fault Tree. The author had field tested the majority of these variables in an earlier study (Rencher, Wadham, and Young, 1978). Listed below are the seven primary and seven secondary teacher variables, and the six primary and three secondary student variables used in this study.

Teacher Behaviors

Primary Motivational Variables.

1. Energizers - Those antecendent teacher behaviors used to elecit a student response.
2. Recognizers - Those consequent teacher behaviors used to positively reinforce a student response.
3. Chastisers - Those consequent teacher behaviors used to negatively reinforce a student response.

Secondary Motivational Variables. (Used to modify Primary variables)

1. Internal - Indicated that Energizers gave the students' choice with no implied contingencies, Recognizers provided student satisfaction for his actions, or, Chastisers

caused student dissatisfaction for his actions.

2. External - Indicated that Energizers gave the student little choice with real or implied contingencies, Recognizers provided student satisfaction for the "pay offs," or, Chastisers provided student dissatisfaction because of the punishment.
3. Non-Facilitative - Indicated that any of the above primary motivational variables, at face validity, were debilitating to the student's self-concept.

Primary Instructional Variables.

1. Explains - Explains instructional tasks and content to the student (content explanation).
2. Questions - Asks a question to elicit an instructional response.
3. Directs - Gives a direct signal to elicit an instructional response.
4. Informs - Gives the student direct feedback as to the correctness or incorrectness of his instructional response (neither recognizing nor chastising).

Secondary Instructional Variables. (Used to modify Primary variables)

1. Concept - Explains, Questions, or Directs for conceptual learning.
2. Memory - Explains, Questions, or Directs for memory learning.

3. Recognition - Explains, Questions, or Directs for student recognition in conjunction with concept of memory learning.
4. Production - Explains, Questions, or Directs for student production in conjunction with concept or memory learning.

Student Behaviors

Primary Variables.

1. Correct - A correct student response to either motivational or instructional elicitor variables.
2. Part-Correct - A partially correct student response to motivational or instructional elicitors.
3. Incorrect - An incorrect student response to motivational or instructional elicitors.
4. No Response - Learner gives no response with relationship to motivational or instructional elicitors.
5. Can't Judge - An overt student response to a motivational or instructional signal which cannot be judged correct or incorrect until later. (Ex: Student writes a response that observer cannot see from his vantage point.)
6. Off Task - Student emits a behavior inappropriate to the motivational instructional task at hand.

Secondary Variables.

1. Other - Other student than one being observed gives responses as teacher directs motivational or instructional elicitors to him. (Used as a modifier to the above student categories. Also, used to indicate which student initiated a response from the teacher.)
2. Student - Used to indicate if the motivational or instructional elicitor was directed specifically to the student under observation. (All teacher elicitors directed to the group were automatically interpreted as also being directed to the student under observation. Used also to indicate which student initiated a response from the teacher.)
3. Teacher - Used to indicate if the student initiated response from the teacher.

Sample

Thirty-nine teachers participated in this study. These were randomly selected from three "pools." The first group consisted of 17 pre-service teacher assistants who were Brigham Young University elementary teacher trainees with little or no previous teaching experience. Their mean age was 21.6 years; most were females. They served in the classroom as assistants to the professional teacher, teaching small groups of children and assisting in other classroom activities. The second group was made up of 9 first year beginning teachers who had recently completed their teacher training at BYU and were hired as full accredited teachers. They, too, were mostly females with a mean age of 24.9 years. The third group consisted of more experienced teachers who

ranged from 2.5 years of teaching experience to 22 years (mean 12.92 years of teaching experience). All of this group were females with a mean age of 42.7 years.

All teachers in this study were teaching in the primary grades (first through third) and were observed while teaching reading to small groups of students.

Instrumentation

The recording tool used in this study was a portable micro-computer system the size of an attache case called TICOR which was developed by a BYU research team (Wadham and Young, 1975). The TICOR system uses a keyboard resembling an electric typewriter. (See Figure 2.) The keyboard allows the research observer to record, simply with the depression of the keys, not only the frequency of occurrences, but also the duration and sequence of the predefined behavioral categories. The TICOR recorder also automatically records the latency time between events plus simultaneous occurrences as more than one key is depressed on the keyboard. As the observer records the events occurring in the research environment, these data are compressed with a micro-compressor within the TICOR recorder then automatically recorded on a digital magnetic tape also housed within the TICOR.

For this study, the motivational and instructional categories previously described were labeled on the TICOR keyboard. An observer was trained to reliably record these variables on the TICOR as they occurred during ongoing classroom instruction. Each teacher in the study was observed on three different occasions while in an instructional

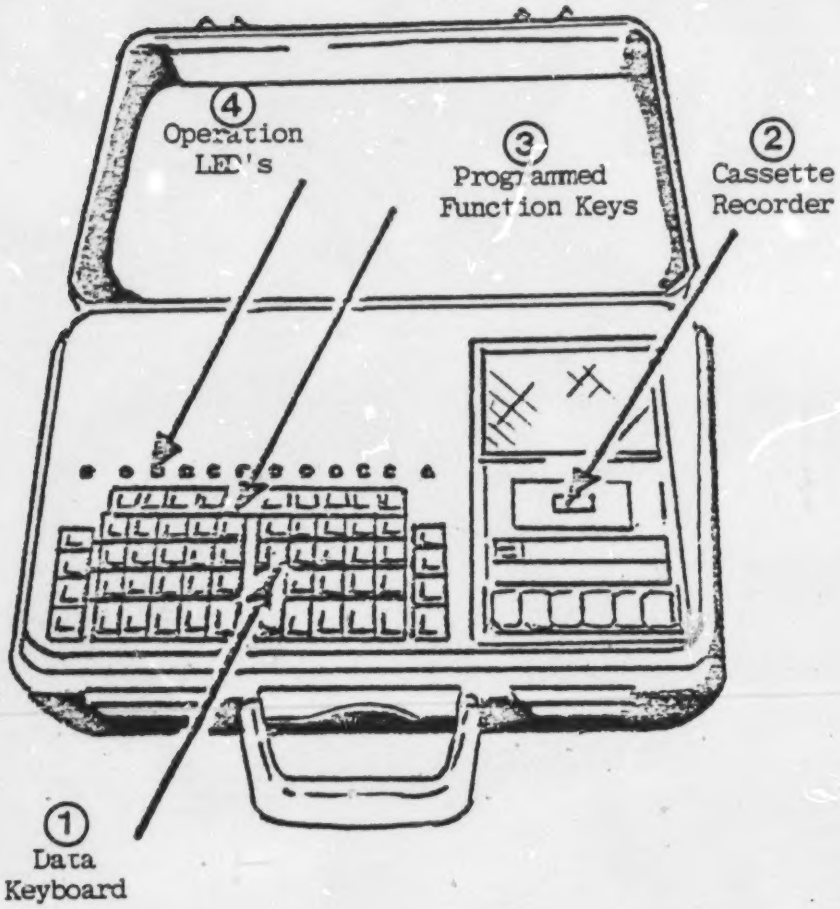

Figure 2

Timed Interval Categorical Observation Recorder (TICOR)
Illustrating: ① Data Keyboard, ② Cassette Recorder
③ Programmed Function Keys ④ Operation LED's

mode for at least five minutes each period. A total of 207 observation cases was obtained in the total study. They were divided among the three teacher groups as follows: 82 cases for the Teacher Assistants, 48 cases for the 1st Year BYU Trained Teachers, and 77 cases for the More Experienced Teachers.

Data Analysis

All raw data were converted into rate per minute. This was done by dividing the total number of minutes of observation for a given observation period into the total number of occurrences of each behavioral category observed during that period.

From these rated data, a stepwise discriminant analysis was used to isolate which of the fifty-seven possible variable combinations best discriminated the three groups of teachers. Discriminant analysis in essence provides new variables called discriminant functions which maximally separate the teacher groups.

A classification analysis was also used to determine what percentage of the observation times or cases could be classified into the correct teacher groupings. Classification functions, by their very nature, are designed to maximize the probability of correctly classifying the observation cases into the appropriate teacher groups.

Further data analysis included a program written especially for TICOR data which determines the recurring patterns or combinations of the research variables. A pattern by definition is a recurring combination of at least two or more variables. For this study, the program was used to indicate the recurring combinations of motivational

and/or instructional variables used by the three teacher groups. The data were analyzed to determine which patterns were unique to each group and which patterns were shared.

Results

Discriminant Analysis

The stepwise discriminant analysis indicated that ten of the fifty-seven original variable combinations produced a distinctive separation between the three teacher groups. These ten discriminating variables were: Null time (an indicator of the time between actual variables), Explains, Explains-Concept, Explains-Memory, Directs, Questions, Chastises, Teacher, No Response, and Student. Table 1 presents the two discriminant functions which accounted for 81 percent and 19 percent of the available discriminating variance for these ten discriminating variables. Each of these functions was significant beyond the .001 level.

To help put these functions in perspective, the average rates of occurrence for each of the ten discriminating variables were also listed by the three teacher groups to the right of Table 1. This will help the reader see which group used the variables most and least.

Using the two functions, two discriminating scores were calculated for each of the 207 observation cases. The average scores were calculated for each of the three teacher groups. Their means are given in Table 2 and are plotted in Figure 3.

Looking at Table 2 in combination with Figure 3, the reader can readily see that the first function produced a large separation

Table 1

Standardized Discriminant Function Coefficients for Teacher Assistants, 1st Year BYU Teachers, and More Experienced Teachers on Ten Variables (57 Original)

Variable	Coefficients (F 2.5) Func 1 (81%)	Func 2 (19%)	Mean Resp/Min TA	1st BYU	ME
Null Time	.768	-.205	12.85	16.35	15.21
Explains	.260	-.179	.83	1.14	1.38
Explains-Concept	.135	.469	.03	.12	.04
Explains-Memory	.224	-.076	.01	.03	.05
Directs	-.066	.697	1.23	1.73	1.30
Questions	.033	.631	1.34	1.33	1.51
Chastises	-.344	.105	.02	.01	.02
Teacher	-.579	-.050	.53	.19	.24
No Response	-.225	.235	.17	.23	.19
Student	-.589	.028	.82	.65	.46

Table 2

Average Discriminant Scores by Two Functions for TA's, 1st Year BYU, and More Experienced Teachers On Ten Variables (57 Original)

Teacher Group	Average Discriminant Scores Function 1 (81%)	Function 2 (19%)
Teacher Assistant (TA)	-.73	-.05
1st Year BYU (1st)	.3	.58
More Experienced (ME)	.54	-.31

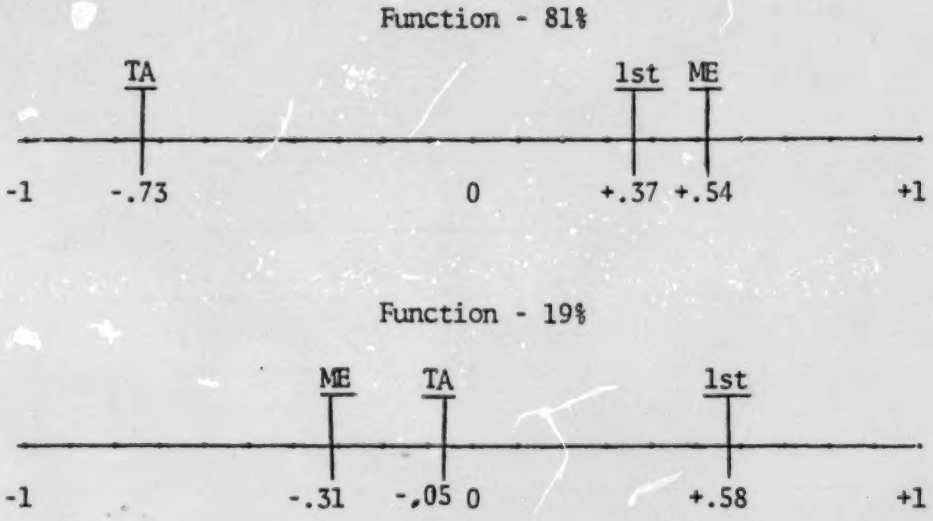

Figure 3

Plots for Average Discriminant Scores For TA's, 1st Year BYU, and More Experienced Teachers by Two Functions

Table 3

Predicted Group Membership for 207 Observation Cases for TA's, 1st Year BYU, and More Experienced Teachers By Ten Variables (57 Original)

Actual Teacher Group	Predicted Group TA	1st	ME	Total
Teacher Assistant (TA)	51 (62.2%)	11 (13.4%)	20 (24.4%)	82
1st Year BYU (1st)	8 (16.7%)	24 (50.0%)	16 (33.3%)	48
More Experienced (ME)	9 (11.7%)	12 (15.6%)	56 (72.7%)	77
	Cases Correctly Classified		131 (63.3%)	207

between Teacher Assistants and the other two teacher groups. The second function separated the 1st Year BYU Trained Teachers from the other two groups.

Classification Analysis

Using the 207 observation cases from all three groups of teachers, the number of cases correctly classified was 131 which is 63.3 percent. Table 3 gives a breakdown of each of the three teacher groups. Out of the 82 Teacher Assistant observation cases, 51 (62.2 percent) were classified correctly. For the 1st Year BYU Trained Teachers, 24 (50 percent) of their 48 cases were classified correctly. More Experienced Teachers had 56 (72.7 percent) of their 77 observation cases classified correctly.

Pattern Analysis

The analysis of variables in combination indicated that 80 specific recurring patterns were shared by all three teacher groups. Teacher Assistants had 46 unique variable combinations. First Year BYU Trained Teachers also had 46 patterns unique to them while the More Experienced Teachers had 49 unique teaching patterns. Space does not permit the inclusion of all these patterns in this report. Only those patterns which contained the discriminating variables are reported in this paper.

Table 4 gives a summary of how the discriminating variables were shared and used uniquely in patterns by the three groups. Note that only nine of the ten discriminating variables are indicated in this

Table 4

Number of Teacher Patterns Shared by and Unique to TA's, 1st Year BYU, and More Experienced Teachers Using Nine Discriminating Variables

Variable	Shared			TA			1st BYU			ME		
	Init.	Med.	Fin. Total	Init.	Med.	Fin. Total	Init.	Med.	Fin. Total	Init.	Med.	Fin. Total
Explains	4-Tchr 1-Stdnt	1	4 = 10	3-Tchr 1-Stdnt	1	1 = 6	5-Tchr	4	2 = 11	5-Tchr 1-Stdnt	1	14 = 21
Explains-Concept	0	0	0 = 0	1	0	0 = 1	0	0	0 = 0	0	0	0 = 0
Explains-Memory	0	0	0 = 0	0	0	0 = 0	0	0	0 = 0	0	0	0 = 0
Directs	10	5	4 = 19	4	3	3 = 10	6	7	3 = 16	9	4	1 = 14
Questions	15-Tchr 4-Stdnt	0	0 = 19	1-Tchr 5-Stdnt	8	3 = 17	6-Tchr	2	0 = 8	7-Tchr	0	0 = 7
Chastises	0	0	0 = 0	0	0	0 = 0	0	0	0 = 0	0	0	0 = 0
Teacher	1	0	5 = 6	0	0	6 = 6	0	0	2 = 2	0	1	1 = 2
No Response	0	0	2 = 2	0	0	1 = 1	0	0	3 = 3	0	1	0 = 1
Student	6	6	1 = 13	3	1	8 = 12	0	2	3 = 5	1	2	2 = 5

table. The variable of Null Time is not indicated because by its very nature it is the absence of behavior or the time between variables, and this does not show up as a pattern variable. The reader will also note that some variables appear in this table not to have occurred during this study. A zero in Table 4 does not necessarily mean a variable did not occur during the observations but rather it did not occur regularly enough to be statistically recorded as a pattern. Finally, the nine variables are recorded in this table according to the number of different patterns they appeared in and the positions within these patterns, i.e., the initial position or starting a pattern, the medial position, and, the final position or ending a pattern, plus whether they were initiated by the teacher or student.

The variable Explains occurred more in patterns for the More Experienced Teacher and proportionately more at the end of the teacher patterns. For More Experienced Teachers, the most recurring pattern using the Explains variable looked as follows: the ME Teachers would elicit a correct student response followed by the teacher informing the student of his correct response followed by explaining more content.

Explaining at a concept level only occurred in one pattern. This was with the 1st BYU Trained Teachers. This variable came in the beginning of the pattern and was only a two variable pattern--the teacher explained at a conceptual level and then questioned the student at a concept recognition level. Note in Table 4 that none of the teacher groups had patterns which incorporated explaining at a memory level though this was a discriminating variable.

The Directs variable was used in more patterns by the 1st Year BYU Trained Teachers. They used this variable more in the middle of their patterns. This group's highest occurring pattern with the Direct variable in the middle started off with the teacher explaining followed by the teacher directing a response which was followed by a correct student response and ended with the teacher informing the student of his correct response. The More Experienced Teachers used the Directs variable more than the other groups in the initial position of their patterns. The most recurring pattern for this group using the Directs variable led off with the teacher giving a Direct signal followed by a correct student response, which the teacher informed was correct followed by an explanation.

Teacher Assistants used the Question variable in patterns more than twice as much as the other two groups. The reader will notice that compared to the other groups, the TA's used this questioning variable more in the middle of their patterns. Also, it can be noted that in the initial position more TA students started the patterns as opposed to the teachers.

Though Chastises was a discriminating variable in the discrimination analysis, it did not occur enough to hold up as a pattern in any of the teaching groups. (Note in Table 1, Chastises had a very low rate of occurrence with mean responses of 2 per hundred minutes for both TA's and ME's.)

The Teacher variable is an indicator of when the students would overtly elicit a response from the teacher. Teacher Assistants had more patterns indicating their students overtly initiated some sort of

teacher response. The Teacher variable occurred at the end of all of the TA's six patterns using this variable. The TA pattern that occurred most using this variable was a short pattern that started with the student asking the teacher a question about his response which was followed by the teacher informing the student about his response.

The No Response variable occurred more in patterns and overall for the 1st Year BYU Trained Teachers than the other groups. The pattern that occurred most with this No Response variable for the 1st Year BYU Trained group looked as follows: the teacher gave a direct signal which was followed by a no response from the student.

Finally, the Student variable occurred more in patterns for the TA's than the other teacher groups. The position within the pattern is especially noteworthy for this variable. When occurring in the front of a pattern, this generally indicates students initiated a pattern (eliciting a response from the teacher). A pattern containing this Student variable in the middle or final position indicated that the teacher directed his motivational or instructional strategy to the particular student under observation. Table 4 indicates that students of TA's initiated more patterns than students of the other two groups. The TA's highest occurring pattern with this Student variable had the variable occurring at the end of a pattern and was as follows: a student was called on followed by a correct student response.

Discussion

The discriminating function, which accounted for 81 percent of the variance between the three groups, indicated what one would

expect; that is, TA's looked considerably different from the professional teachers.

Both professional groups had higher rates of Null Time than the TAs. This variable is an indicator of the overall pacing of instruction. The higher rates of Null Time indicate more variables are used in an observation. The more professional teachers tended to have a more rapid instructional pace, the 1st Year BYU Trained Teachers having the highest. In Bloom's (1976) recent publication of the effects of teaching on student achievement, instructional strategies that are proving effective are those which provide for instructional cues, student participation, feedback, and corrective procedures. This type of strategy resembles a highly interactive process between the teacher and the student. The Null Time variable is an indicator of this type of instruction.

Related to the Null Time variable was the Explains variable. Again, the two professional groups had a higher rate of presenting content (cueing) as evidenced by this variable. This, too, fit the effective instructional pattern discussed by Bloom (1976). The reader will note that the most recurring instructional pattern for the ME Teachers using the Explains variable has three elements of Participation (correct student response), Feedback (informing student of his correct response), and Cueing (explaining more content) in that order.

Another indicator of effective teaching is simply the amount of correct responses a student makes in a given amount of instructional time or his rate of participation (Bloom, 1976). The students of the

More Experienced Teachers and 1st Year BYU Trained Teachers had the highest ratios of correct student responses to incorrect with a ratio of 15 to 1. TA's had a ratio of 11 correct to 1 incorrect student responses.

How the groups elicited student responses was especially interesting. 1st Year BYU Trained Teachers used the Directs signal more than the other two groups while the More Experienced Teachers used a higher rate of Questions to elicit student responses. Yet, it must also be noted that the Questions variable showed up more in patterns with the TA group.

Overall, the ten discriminating variables indicated that TA's tended to Chastise more plus they had more "give and take" with their students as indicated by their higher rates of Teacher and Student variables. While 1st Year BYU Trained Teachers were "high pacers," using more concept explanations and direct signals which in turn interestingly produced a higher rate of no responding as compared to the other groups, More Experienced Teachers in turn were particulary discriminated by the highest rates of explaining with much explaining at the memory level, plus chastising to manage the students.

Through the use of the categorical system generated from the teaching model used in this study, teachers of differing teaching backgrounds were readily and descriptively discriminated. Also, this study has demonstrated the "rich" data bank that can be conveniently gathered with the TICOR micro-computer system.

Further study of the teaching model with larger teacher populations using the unique and comprehensive TICOR data analysis system has the potential of bringing answers to the important question of: what are the critical teaching competencies which facilitate learning?

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